

CLAIMS

1. A mini-fan that comprises:

a drive motor having an external rotor (222) and an internal stator (244), which external rotor is equipped with a rotor shaft (234) that is equipped with a necked down portion (258) adjacent its free end (235);

a bearing tube (238) on whose outer side the internal stator (244) is mounted, and in whose interior is arranged a bearing arrangement (236) in which the rotor shaft (234) is rotatably supported;

a closure arrangement (62; 262) that closes off the bearing tube (238) in liquid-tight fashion at one end, and is equipped adjacent the necked down portion (258) of the rotor shaft (234) with at least one resilient securing member (260) that engages into that necked down portion (258) of the rotor shaft (234) and secures the rotor shaft (234) against being pulled out of the bearing arrangement (236).

2. The mini-fan according to claim 1, wherein

the closure arrangement is implemented in the manner of a cover (62) that is made from a thermoplastic that is at least partially transparent to laser light, that cover (62) being attached by means of a substantially liquid-tight welded join (100, 102).

3. The mini-fan according to claim 2 which comprises

a housing having a flange (78); and

the welded join (100, 102) is provided at a location at which the cover (62) at least partly overlaps a portion of that flange (78).

4. The mini-fan according to claim 2 or 3, which comprises a housing having a flange (78), wherein

the bearing tube (38) is held between the closure arrangement implemented in the manner of a cover (62) and a portion of that flange (78).

5. The mini-fan according to any of claims 2 to 4, wherein the bearing tube (38) is pressed in substantially liquid-tight fashion into an opening (80) of the flange (78).

6. The mini-fan according to claim 5, wherein

the bearing tube (38) is implemented as a metal part, and is epilam-coated on its side that is pressed into the flange opening (80).

7. The mini-fan according to any of claims 3 to 6, wherein

the bearing tube (38) is equipped with a radial projection (82) that is held in positively engaged fashion between the closure arrangement (62) implemented in the manner of a cover and a portion of the flange (78).

8. The mini-fan according to claim 7, wherein  
the radial projection is implemented in the manner of a flange (82).

9. The mini-fan according to claim 8, wherein  
the flange (82) is provided on an end portion of the bearing tube (38).

10. The mini-fan according to any of the preceding claims, wherein  
the rotor shaft (34; 234) comprises a free end (35; 235), facing away from  
the rotor (22; 222), on which a tracking cap (68; 268) is formed for axial  
support;

and wherein a support surface (66; 266) for that tracking cap is  
provided on the closure arrangement (62; 262).

11. The mini-fan according to claim 10, wherein  
the support surface is implemented as a depression (66; 266) and is  
equipped with a lubricant (110).

12. The mini-fan according to any of the preceding claims,  
wherein the at least one resilient securing member (60; 260)  
protrudes into the necked down portion (58; 258) of the rotor shaft (34;  
234) without touching it.

13. The mini-fan according to claim 12, wherein  
there is provided, adjacent the free end of the shaft (34; 234),  
a spreading member (35; 235) that is implemented to deflect the at least  
one resilient securing member (60; 260) in a radial direction upon  
installation of the shaft (34; 234).

14. The mini-fan according to any of claims 10 to 13, wherein  
the tracking cap (68; 268) is acted upon by a magnetically generated  
force ( $F_m$ ) in the direction toward the closure arrangement (62; 262).

15. The mini-fan according to any of the preceding claims, wherein  
the closure arrangement is implemented in the manner of a plug (262)  
that is mounted in an opening (271) of the bearing tube (238).

16. The mini-fan according to claim 15, wherein  
the closure arrangement (262) implemented in the manner of a plug is  
pressed in liquid-tight fashion into the opening of the bearing tube (238).

17. The mini-fan according to claim 15 or 16, wherein  
at the transition point (271, 283) between the bearing tube (238) and  
plug (262), there is implemented on one of those parts an annular ridge  
(284, 285) and on the other part an annular groove (272, 273) complementary  
thereto, which together form a latching connection when the plug (262) is  
installed.

18. The mini-fan according to any of claims 15 to 17, wherein the bearing tube (238) has a larger inside diameter at its portion (271) provided for reception of the plug (262) than at its portion (240) provided for reception of the bearing arrangement (236).

19. The mini-fan according to any of the preceding claims, wherein the bearing tube (238) comprises a portion (278) that protrudes away from the rotor (222) and is implemented for installation in an opening (280) of a component (217).

20. The mini-fan according to any of the preceding claims, wherein the internal stator (44; 244) comprises a lamination stack (45; 245) on which is arranged a coil former (46; 246) having a stator winding (247), and mounted on that coil former is at least one rigid electrical conductor (132; 288) that is electrically connected to the stator winding (247) and preferably extends substantially parallel to the rotation axis (41; 241) of the mini-fan.

21. The mini-fan according to claim 20, wherein the bearing tube (238) comprises an outwardly protruding flange (239) that is equipped with an orifice (292) for the passage of the rigid electrical conductor (288).

22. The mini-fan according to any of the preceding claims, wherein the internal stator (44; 244) comprises a lamination stack (45; 245) and the external rotor (22; 222) comprises a permanent magnet (28; 228) coacting with the internal stator, which magnet is offset relative to the lamination stack (45; 245) of the internal stator (44; 244) in such a way that a magnetic force ( $F_m$ ) is generated which acts upon the tracking cap (68; 268) in the direction toward the support surface (66; 266).

23. The mini-fan according to any of the preceding claims,  
wherein an end portion (32; 232) of the shaft (34; 234) is joined to  
a fan wheel (26; 226);

and in the region of the transition from the shaft (34; 234) to the  
fan wheel (26; 226); a surface (112; 312) is provided which extends  
approximately radially and is located inside the bearing tube (38; 238), so  
that lubricant (110) thrown off from that surface upon rotation of the fan  
wheel is thrown into the interior of the bearing tube (38; 238).

24. The mini-fan according to claim 23,  
wherein the approximately radially extending surface (112; 312) is  
implemented in undercut fashion.

25. The mini-fan according to claim 23 or 24,  
wherein the bearing tube (38; 238) comprises, in the region of its  
end facing away from the cover (62; 262), an inwardly protruding portion  
(114; 314).

26. The mini-fan according to claim 25,  
wherein the inwardly protruding portion (114; 314) is separated from  
the fan wheel (26; 226) at least locally by a gap (116; 316) that is  
implemented in the manner of a capillary gap in order to reduce the  
emergence of lubricant (110) through that gap.

27. The mini-fan according to claim 25 or 26,  
wherein the inwardly protruding portion is implemented, on its side  
facing toward the closure arrangement (62; 262), in the manner of an  
undercut (114; 314).

28. The mini-fan according to any of the preceding claims,  
wherein a sintered bearing (36; 236) is provided in order to support  
the shaft (34; 234), which bearing is arranged in the bearing tube (38;  
238) that preferably comprises on its inner side a portion (138) of reduced  
diameter for reception of the sintered bearing (36; 236).

29. A mini-fan having a housing (74) that is equipped with a flange portion (78) that in turn comprises a flange opening (80),  
having a cover (62) for closing off that flange opening (80),  
further having a join (100, 102) provided between the flange portion (78) and the cover (62),  
and having a bearing tube (38) in which a bearing arrangement (36) for a shaft (34) of the fan is located;  
the bearing tube (38) being held in positively engaged fashion between the cover (62) and flange portion (78).

30. The mini-fan according to claim 29,  
wherein the bearing tube (38) is pressed in substantially liquid-tight fashion into the flange opening (80).

31. The mini-fan according to any of claims 28 to 31,  
wherein the bearing tube (38) is equipped with a flange (39) that is held in positively engaged fashion between the cover (62) and the flange portion (78).

32. The mini-fan according to any of claims 28 to 31,  
wherein the join between the flange portion (78) and cover (62) is implemented as a welded join (100, 102).

33. The mini-fan according to any of claims 28 to 32,  
wherein the shaft (34) of the fan comprises a free end (35);  
and a holding apparatus (60) that is implemented to retain that free end (35) is provided on the cover (62).

34. The mini-fan according to any of claims 28 to 33,  
wherein the shaft (34) of the fan has a free end (35) that is equipped with a tracking cap (68) associated with which is a corresponding depression (66) in the cover (62), which depression forms, together with the tracking cap (68), a bearing for the shaft (34).

35. The mini-fan according to any of claims 5 to 34,  
wherein the bearing tube (38) comprises a constriction (37) in which a sintered bearing (36) is mounted.

36. The mini-fan according to claim 35,  
wherein the inner side (40) of the constriction (37) has a  
better-machined surface than other, unconstricted portions of the inner  
side of the bearing tube (38).

37. A mini-fan, having a fan wheel (22) that is equipped with a shaft  
(34) for support thereof,  
having a sintered bearing (36) to support that shaft (34),  
having a bearing tube (38) for reception and retention of the  
sintered bearing (36), which bearing tube comprises on its inner side a  
portion (37) having a reduced inside diameter, in which portion the  
sintered bearing (36) is mounted.

38. The mini-fan according to claim 37,  
wherein the sintered bearing (36) comprises a portion (42) having an  
enlarged outside diameter, which outside diameter corresponds approximately  
to the reduced inside diameter of the bearing tube (38) in order to permit  
mounting of the sintered bearing (36) in the bearing tube (38) in the  
region of that portion (42) having an enlarged outside diameter.

39. The mini-fan according to claim 37 or 38,  
wherein the bearing surfaces (48, 50) of the sintered bearing (36)  
are located substantially outside the portion (42) having an enlarged  
inside diameter.

40. The mini-fan according to any of claims 37 to 39,  
wherein the bearing surfaces (48, 50) of the sintered bearing (36)  
are located substantially at locations that are located outside the  
locations at which the sintered bearing (36) is held in the bearing tube  
(38).

41. The mini-fan according to any of claims 37 to 40,  
wherein the shaft (34) comprises a free end (35) facing away from the  
fan wheel (22),  
and in the region of this free end (35) at least one closure member  
(62) is provided which seals that end (39) of the bearing tube (38) in  
substantially liquid-tight fashion.

42. The mini-fan according to claim 41,  
wherein a lubricant supply (64) is provided in the region of the  
sealed end (39) of the bearing tube (38).

43. The mini-fan according to claim 41 or 42,  
wherein the shaft (34) is equipped in the region of its free end (35)  
with a tracking cap (68), associated with which in the closure member (62)  
is a corresponding running surface (66) that, together with the tracking  
cap (68), forms an axial bearing for the shaft (34).

44. The mini-fan according to any of the preceding claims,  
wherein the shaft (34) comprises a free end (35) facing away from the  
fan wheel (22),  
and in the region of that free end (35) an annular groove (58) is  
provided into which protrudes, in the assembled state, a resilient latching  
member (60) that is mechanically connected to the housing of the mini-fan  
and counteracts pulling of the installed shaft (34) out of the sintered  
bearing (36).

45. The mini-fan according to claim 45,  
wherein the resilient latching member (60) is implemented integrally  
with a closure member (62) which serves to close off the bearing tube (38)  
in substantially liquid-tight fashion.